Project Plan for the Pacific 2001 Field Study

Shao-Meng Li

Project Leader

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1. Background

The Lower Fraser Valley airshed contains the majority of the population of British Columbia and continues to have a high population growth. Because of its unique geographic features and the large population, the valley experiences the interaction of urban, suburban, marine, and agricultural emissions of pollutants and their subsequent transformation in ambient air. As such, fine particulate matter and surface ozone dominate the air quality agendas of the public, planners and policy makers at all levels of government. The application of the Canada Wide Standard (CWS) on ozone and fine particulate matter in the Lower Fraser Valley is inevitable. Understanding the issues related to the sources and formation of ozone and fine PM will require a sound scientific understanding of both issues.

In the summer of 1993, the PACIFIC '93 field study was carried out in the Lower Fraser Valley to enhance our understanding of the physical and chemical processes important in the formation of ground level ozone. The insights gained during the study have been presented at many scientific venues and conferences including a special session at the 1994 Fall American Geophysical Union Meeting and published in a special issue of Atmospheric Environment (Volume 31, No.14, July 1997). Information from Pacific '93 has been used in public forums to provide the residents of the Lower Fraser Valley a clearer picture of the mechanisms and sources of air pollution. Analysis of the field study measurements have assisted in the siting of new monitoring stations within the Lower Fraser Valley Air Quality Monitoring Network. The field study results have provided a very useful data set to develop and evaluate regional smog models that have been used in the development emission control strategies for ground level ozone and in the analysis of emission control strategies related to vehicle tailpipe standards.

This notwithstanding, limited measurements of PM were made during Pacific '93 to provide insights into the composition, size distribution and vertical profiles of PM. The resulting PM data sets were not adequate for the development and evaluation of regional PM models which support policy development by predicting both PM and ozone formation. Because the issue of PM and ozone are closely intertwined, to address the PM issue in the Lower Fraser Valley, a comprehensive scientific data set, including those related to PM and those related to ozone formation, must be obtained concurrently, together with representative meteorological processes, to serve as the basis for model evaluation and enhancement. The proposed study, PACIFIC 2001, is aimed at providing this needed information on both PM and ozone to ensure that policy development is based on sound science.

This document outlines the organizational structure of the program, the scientific objectives, the data quality objectives, the deliverables, and schedules. Specific sections will be devoted to the planned measurement activities during the field study and the model evaluation activities thereafter. Although the program is still in the planning stage, the tight timelines, dictated by the needs of the different funding sources, cannot be easily changed. As such, the schedules related to the actual fieldwork will be fairly solid, whereas those related to the model evaluation remain to be better defined.

2. State of the Knowledge on PM and Related Activities in the LFV

The Pacific '93 Oxidant Study produced substantial amount of information regarding the oxidant formation in the Lower Fraser Valley. The study first identified the significant role of biogenic hydrocarbons, in particular isoprene, as a very important contributor to the ozone formation process [Biesenthal et al., 1997]. It also clearly showed that the boundary layer meteorological structure has strong influence on the distribution of pollutants in the valley [Pisano et al., 1997; Hayden et al., 1997; McKendry et al., 1997]. The study included a tunnel study that characterized the emissions of CO, NO_x, and NMHC from the mobile source in the area [Gertler et al., 1997]. In addition, the study marks a successful application of lidar to provide the spatial distribution of particulate matter in the valley [Hoff et al., 1997]. The data set has been extensively analyzed (see the special issue in Atmospheric Environment, 1997 and later publications) and has been used in UAM/V and Model3/CMAQ model evaluation. However, only limited data were obtained for PM, particularly on physical characteristics, and these have not been published in the literature.

Subsequent to Pacific 93, additional measurements in the valley provide valuable insights in the physical and chemical processes involved in the formation of particulates and ground level ozone. REVEAL I (summer of 1993) and REVEAL II (1994-95) provided a wealth of data and a baseline on the inorganic chemical characteristics of the aerosols at two locations in the valley. Analysis of the REVEAL results identified significant fraction of the particulate mass as organic-related materials, as well as from NH_3 that is a product of many sources such as agricultural and transportation sectors. About one third of PM mass is carbon related to sulfate and one third to nitrate at several locations across the valley. The importance of the mobile sector was well documented in the fine particle mass, as >40% of the mass was attributed to transportation sector [Pryor and Barthelmie, 1996, 1999].

The Lower Fraser Valley Air Quality Network provides ongoing coverage of the Valley particularly the Greater Vancouver Area with measurements of criteria pollutants (including PM and ozone) and meteorology. Results from the network indicate that the maximum PM_{10} level in the valley occurs during fall season from late August to September. The National Air Pollution Surveillance (NAPS) program has provided a considerable data set for the smog precursors NOx and VOCs at a number of selected sites within the network.

Additional measurements have been carried out. Through the Fraser River Action Plan, measurements of atmospheric chemistry have been made at Agassiz, Abbotsford and Burnaby Lake. These regional programs include weekly measurements of inorganic and organic gaseous concentrations, concentration in rainfall and subsequent deposition calculations. As part of the Georgia Basin Ecosystem Initiative (GBEI), measurements of inorganic and organic compositions in particulate matter have been made using Hi-Vols and more recently using MOUDI at a number of locations in the valley. In addition, in the GBEI, a program that determines the emissions of dimethyl sulfide (DMS) from the Strait of Georgia is underway. The results are now under evaluation.

The Inorganic and Secondary Organic PARTicle (ISOPART) model [Pryor and Barthelmie, 1996, 1999] has been applied to the REVEAL I and REVEAL II datasets. The model validates well against data on inorganic components of PM in the valley. It also sheds light on the importance of biogenic emissions, such as DMS from marine sources and the emissions from vegetation (eg. monoterpenes). The model results on DMS and biogenic particulate matter in the valley, however, need further validation due to lack of ambient data during both REVEAL studies. While the DMS emission is being addressed during the current GBEI study, few measurements exist for the monoterpenes and their oxidation products in the valley.

The emissions inventory has been completed for 1995 that covers the entire airshed and is suitable for modeling applications. This inventory includes size speciated fine particulate as well as ammonia emissions (area and mobile emissions are gridded at 5 km). There are some questions concerning the biogenic emissions inventory, particularly the monoterpenes, as there appears to be some inconsistencies along the US-Canada border. This needs to be resolved during the field study.

3. Scientific Objectives of Pacific 2001

The overall objective of Pacific 2001 is to provide a better understanding of, and reduce the uncertainty of the sources, formation and distribution of PM and ozone in the Lower Fraser Valley. To achieve this overall objective, specific goals are set to

- determine the horizontal and vertical distribution of fine particulates and ozone in the LFV airshed. In particular, to determine the transition from an emission-dominated regime to a formation-controlled regime in the valley
- determine the physical and chemical characteristics of fine particulates in the LFV airshed, and to determine the changes in these properties in the region
- identify the major physical and chemical processes in the formation of secondary aerosols and ozone
- determine the roles of biogenic and anthropogenic (transportation sector) emissions in SOA and ozone formation
- provide an integrated data base for evaluation of regional PM and ozone computer models

By achieving these objectives, the field study will describe the formation and the spatial and temporal distribution of particulate matter and ozone and the significance of the dominant emission sources. This information will be used to develop and evaluate air quality models as they are applied to assess the impact of new initiatives such as the adoption of Canada Wide Standards for Ozone and Fine Particulate Matter. The integrated database can also be, and will be, used for client studies such as health impact through the TSRI related research activities, visibility studies, and other impact studies such as the GBEI.

Based on the data from the GVRD monitoring stations and the results from previous studies including Pacific ’93 and the REVEAL series, it has been decided that the field experiment should begin from the middle of August to the middle of September. This time period experiences the highest PM mass concentration, and provides the best time window to gain a good understanding of issues related to PM in the valley. Details of the project planning and the scientific means to achieve the objectives are further outlined below.

4. Organizational Structure and Partnership

Pacific 2001 is effectively a collection of several research projects, and with additional activities that link these projects together. The objectives of Pacific 2001 reflect the combination of those of the member projects. The member projects include the Georgia Basin Ecosystem Initiative (GBEI), the PERD project on the transportation sector contribution to urban particulate matter, the TSRI project on urban air quality, and the NSERC strategic project on biogenic particulate matter formation. Objectives of these member projects overlap, particularly in the understanding of fine PM in the valley, hence creating opportunities for these projects to be closely interlinked. Additional projects within Pacific 2001 are initiated to connect and coordinate the various activities of these main projects. Thus through an effective combination of the additional projects with the member projects of the GBEI, PERD, TSRI, and NSERC, a comprehensive data set will be collected that not only satisfy the needs of the main components but provide a much clearer overall picture of fine PM in the valley. The data set will address the objectives of the member projects but also the overall project objectives of Pacific 2001.

Environment Canada is leading the Pacific 2001 study with overall planning and with managerial support from both the Meteorological Service of Canada and the Environment Canada Yukon and Pacific Region. It is also providing the majority of the funding for this project. Partners in the project include Canadian federal agencies from the Panel on Energy Research and Development (PERD), the Toxics Substance Research Initiatives (TSRI), the B.C. Ministry of Environment, Lands and Parks (through GBEI), and the private sector through the Canadian Petroleum Producers Institute (CPPI), and the GVRD Lower Fraser Valley Air Quality Network. The US partners are the PNNL of US Department of Energy and EPA Region 10. Canadian university partners are funded through the NSERC, the Canadian Foundation for Climate and Atmospheric Sciences, and TSRI. US university partners are funded through this project and through US EPA.

5. Field Campaign Components and Mode of Operations

To achieve the outlined objectives, particularly those relating to the generation of a comprehensive database suitable for model evaluation, a project plan on the measurement strategies has been formulated. Separate plans for the model development and evaluation have been drawn (References). To address the PM horizontal and vertical distribution issues, both ground and airborne measurements are to be carried out. At ground sites, a broad range of measurements will be carried out to address the particulate matter characterization and the processes that lead up to the formation of the particulate matter, particularly those related to the precursor gases and the gas phase oxidant formation processes. A special study is also planned to determine the particulate matter emissions from the transportation sector as well as the impact of biogenic sources on PM formation in the Valley.

Five main ground sites have been identified as suitable to address these aspects of the objectives, each deploying different sets of chemical and physical measurements at the individual locations. In combination these sites, together with the existing GVRD monitoring sites, also serve the purpose of detecting the spatial differences in the chemical parameters being measured. These four locations are shown in Figure 1. They are

- the Cassier Tunnel site (marked C in the figure), where the measurements represent the emissions from the mostly light-duty transportation sector;
- the Slocan Park site (B), which represents an urban/suburban setting in the Vancouver urban center, where a mixture of primary particles and secondary particulate matter is expected. The secondary particulate matter at this site is expected to have significant impact from anthropogenic precursors such as the oxidation of aromatic hydrocarbons;
- Langley Ecole Lochiel site (L), where the transition from an urban setting to the rural setting is expected to take place, and where the formation of particulate matter from agricultural practices in the valley is expected. This location is also expected to experience significant particulate matter evolution from those observed at either Slocan Park site and the Cassier Tunnel;
- The Eagle Ridge site (S) on the Sumas Mountain. This is a site located on the eastern part of the valley. This site will address the impact of ammonia emissions in the inner valley east of the Sumas Mountain, the visibility reduction issue, and the interaction between urban pollution and biogenic emissions.
- The Golden Ears Park site (F). The main task of this site is to understand the formation process of biogenic particulate matter from precursors such as monoterpenes, and how this process will impact on the PM in the valley overall.

Additional locations are considered where limited automated instrumentation may be setup. These locations are near the boundaries, such as the Reiffel Island. Spatial survey of particle inorganic composition, particularly ammonium salts and gas, on the eastern portion of the valley will be carried out, with a focus on the impact of agricultural ammonia emission on the particulate formation in particulate matter. Their purposes are to provide boundary conditions at the Reiffel Island.

Vertical distribution of certain parameters, such as O_3 and meteorological parameters, in the lower part of the atmosphere will also be assessed from tethered balloons at both the Slocan Park and the Langley Ecole Lochiel sites. This will be further aided by a scanning lidar that will be based at the Langley site.
To address the spatial and temporal variability of parameters related to PM, airborne measurements are to be carried out from a Convair 580 and potentially from a smaller aircraft. This airborne platform will be used to map the spatial PM distribution in the valley, in both the horizontal and vertical directions. Details of the airborne operations will be presented in the following sections.

The measurement methodology includes those addressing the different aspects of the question. These can be grouped into five categories.

- Measurements related to the precursors of fine PM and the oxidation environment in which the fine PM is formed.
- Measurements related to the characterization of fine PM and the evolution process of PM.
- Measurements related to the emission of fine PM and its precursors in the valley.
- Measurements related to the mapping of fine PM horizontal and vertical distribution in the valley, and
- Measurements of meteorological parameters in the valley.

The instrumentation package at each location reflects the mission for the particular location, as outlined above. The details of the measurement programs at each site and the aircraft operations are given below.

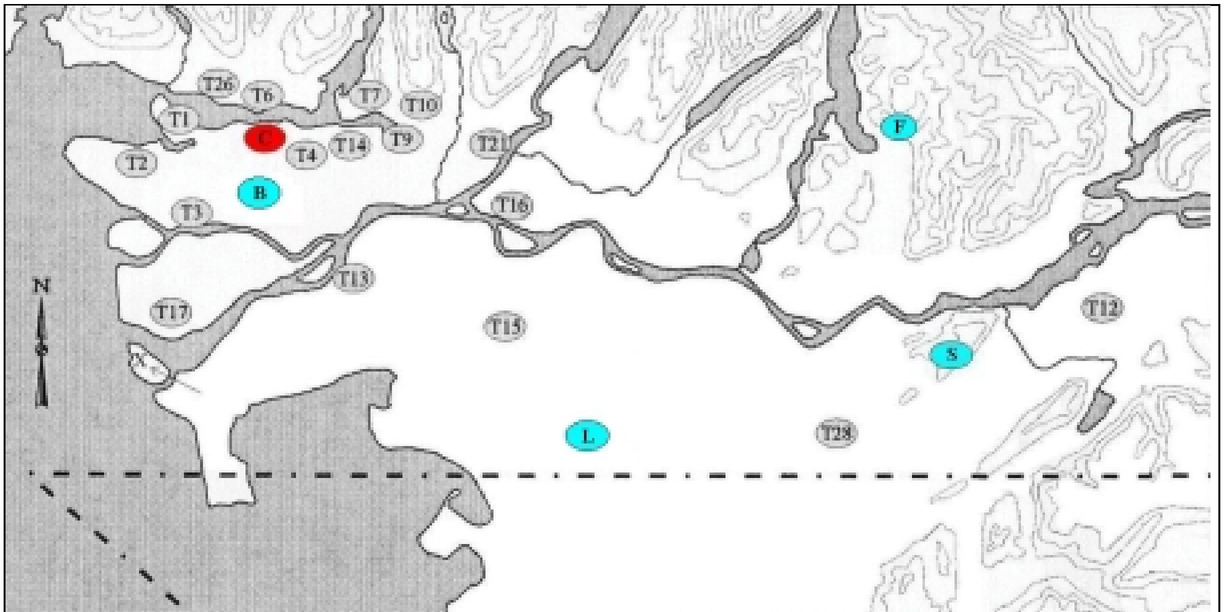

Figure 1. Lower Fraser Valley map. The numbered locations are the GVRD Air Monitoring Network sites. The Pacific 2001 field study sites are marked with letters. The Cassier Tunnel site is marked C. The Slocan Park site is marked B. The Langley Ecole Lochiel site is marked L. The Eagle Mountain site at the Sumas Mountain is marked S. The Golden Ears site is marked F. The aircraft will be based at the Abbotsford Airport, which is near the location T28.

5.1. Measurements at the Cassier Tunnel site

The goal of measurements at this site is to reduce the uncertainty in mobile source emissions inventory for gaseous and particulate matter emissions in the Lower Fraser Valley, and hence provide data for model development and evaluation. The setup of the study is based on that published earlier [Rogak et al., 1998a, 1998b]. Because of this, the instrumentation package is targeted at emissions of the precursors to PM formation. Duration of the emission study will be from 7-10 days. For most measurements, two sets of instruments will be deployed, one at each end of the tunnel. In addition to the tunnel measurements, fuel and lubricating oil surveys will be carried out. The results will be compared with tailpipe emissions data from traditional mobile source emissions testing conducted in laboratory, particularly for mass emission rates and chemical profiles. The results will also be compared to PART5 and/or MOBILE6 to evaluate they performance for the Lower Fraser Valley settings. Table 1 lists the planned measurements at this site. For some measurements, different sampling and analytical techniques will be used to ensure the accuracy of the measurements.

Table 1. Measurement techniques planned for the Cassiar Tunnel site.

Species	Technique	Time Resolution	Frequency	PI
Gas Phase Measurements				
NO, NO_2 (outside tunnel)	Chemiluminescence	1-min	Continuous	GVRD
NO_2	DNPH cartridges	3-hrs	3/day	Graham – EPS
SO_2 (outside tunnel)	Pulse fluorescence	1-min	Continuous	GVRD
SO_2	K_2CO_3 impregnated filter – IC	3-hrs	3/day	Graham – EPS
CO (outside tunnel)	IR-absorption - gas correlation	1-min	Continuous	GVRD
CO_2 (outside tunnel)	IR absorption	1-min	Continuous	GVRD
Organic acids	KOH-impregnated filters – IC	3-hrs	3/day	Graham – EPS
NH_3	Citric acid – impregnated filter – IC	3-hrs	3/day	Graham – EPS
C1-C7 Carbonyls	DNPH-cartridges	3-hrs	3/day	Graham – EPS
NMHCs, iucluding aromatics	Canisters – GC/FID	3-hrs	3/day	Graham – EPS
CO	Canisters-GC	3-hrs	3/day	Graham – EPS
CO_2	Ganisters-GC	3-hrs	3/day	Graham – EPS
CH_4	Canisters – GC	3-hrs	3/day	Graham – EPS
N_2O	Canisters – GC	3-hrs	3/day	Graham – EPS
SF_6	Canisters – GC	3-hrs	3/day	Graham – EPS
CO	FTIR spectrometer	1-min	Continuous	Graham – EPS
CO_2	FTIR spectrometer	1-min	Continuous	Graham – EPS
NO	FTIR spectrometer	1-min	Continuous	Graham – EPS
NO_2	FTIR spectrometer	1-min	Continuous	Graham – EPS
N_2O	FTIR spectrometer	1-min	Continuous	Graham – EPS
SF_6	FTIR spectrometer	1-min	Continuous	Graham – EPS
CH_4	FTIR spectrometer	1-min	Continuous	Graham – EPS
SO_2	FTIR spectrometer	1-min	Continuous	Graham – EPS
NH_3	FTIR spectrometer	1-min	Continuous	Graham – EPS
Semivolatile organic compounds (C_{10}-C_{25} alkanes, high MW aldehydes and aromatics)	Tenax cartridges – GC/FID or GC/MS	9-hrs	1/day	Graham – EPS

Particle Chemical Characterization Measurements				
PM_{10} or $PM_{2.5}$ (outside tunnel)	TEOM	1-min	Continuous	GVRD
$PM_{2.5}$ mass	Low-vol FP – microbalance weight difference	3-hrs	3/day	Graham – EPS
OC/EC (<2.5 μm)	Low-vol FP – thermal optical detection	3-hrs	3/day	Graham – EPS
PM_1 mass	Low-vol FP – microbalance weight difference	3-hrs	3/day	Graham – EPS
OC/EC (<1 μm)	Low-vol FP – thermal optical detection	3-hrs	3/day	Graham – EPS
Trace organic species – PAHs, alkanes, biomarkers, polar	Low-vol FP – solvent extraction – GC/MS or GC/FID	9-hrs	1/day	Graham – EPS
Trace organic species –organic ions	Low-vol FP – IC	3-hrs	3/day	Graham – EPS
Inorganic ions	Low-vol FP – IC	3-hrs	3/day	Graham – EPS
Trace metals	Low-vol FP – XRF	3-hrs	3/day	Graham – EPS
Trace organics species – non-polar (<2.5 μm)	Hivol FP – solvent extraction – GCMS	12-hrs	2/day	Brook/Li/Blanchard /Cheng – MSC
Trace organics species – polar (<2.5 μm)	Hivol FP – solvent extraction – GCMS/GC FID	12-hrs	2/day	Brook/Li/Blanchard /Cheng – MSC
Trace organics species – polar (<2.5 μm)	Hivol FP – solvent extraction – derivatization -GCMS/GC FID	12-hrs	2/day	McLaren – York U. McCarry – McMaster
Carbon isotope (<2.5 μm and 2.5-15 μm)	Hivol FP – TOT-IRMS, GC-IRMS	12-hrs	2/day	Brook/Huang/Li – MSC
Particle Physical Characterization Measurements				
Number size distribution (0.06-300 nm)	Differential mobility analyzer	10-min	Continuous	Graham – EPS Leaitch – MSC
Number size distribution (0.12-3 μm)	Optical scattering probe	1-min	Continuous	Leaitch – MSC
Meteorological and Ancillary Measurements				
T, P, RH WD, WS (outside tunnel)	Meteorological package	1-min	Continuous	GVRD
Vehicle speed	Remote Sensing	N/a	N/a	Graham – EPS
Traffic counting	Strip counters and Remote Sensing	N/a	N/a	Graham – EPS
Vehicle identification	Remote Sensing	N/a	Continuous	Graham – EPS

Tunnel air flow rates	SF_6 tracer in canister	3-hrs	3/day	Graham – EPS Rogak – UBC
Tunnel air flow rates	anemometers	1-min	Continuous	Rogak – UBC
T, P, RH WD, WS (outside tunnel)	Meteorological package	1-min	Continuous	Rogak – UBC
Road dust sampling	GVRD protocol	N/a	One time only during the study	GVRD
Fuel survey including diesel, gasoline, and lubricating oil	Pacific '93 suite of chemicals and also sulfur, manganese, lead	N/a	One time only during the study	CPPI

5.2. Measurements at the Slocan Park site

Measurements at the Slocan Park site in Vancouver are intended to address all issues, with an emphasis on the mixing of primary particles and secondary particulate matter that is expected from conversion of anthropogenic hydrocarbons. The site is situated in a typical suburban setting, surrounded by low-rise residential houses of at least 80 meters away. The site has good fetch in all directions with no major point sources within a radius of 3 km. Traffic in the nearby streets is typical of light volume. The planned instrumentation packages include those in all five categories. Table 2 lists the measurements that are planned for this site, the time resolution, and the principal investigators.

Table 2. Planned measurements at the Slocan Park site during the Pacific 2001 field study. Time resolutions of the measurements are also listed.

Species	***Technique***	***Time Resolution***	***Frequency***	***PI***
		Gas Phase Measurements		
O_3	UV-photometry	1-min	Continuous	Anlauf – MSC
NO, NO_y	Chemiluminescence	1-min	Continuous	Anlauf – MSC
PAN/PPN	GC	5-min	Continuous	Bottenheim – MSC
HNO_3	annular denuder	4-hr	5/day	Brook – MSC
HNO_2	annular denuder	4-hr	5/day	Brook – MSC
Speciated NMHC	Canister-capillary GC	Integrated 5-30 min	Every 3 hrs Every hour intensive	Wang – EPS
NH_3	coil-fluorescence	1-hr	Continuous	Pryor – Indiana U.
SO_2	Pulse fluorescence	1-min	Continuous	Anlauf/Brook – MSC
CO	IR-absorption - gas correlation	1-min	Continuous	Anlauf – MSC
HCHO	DNPH cartridge	1-hr	Every 3 hrs	Wang – EPS
CH_3CHO	DNPH cartridge	1-hr	Every 3 hrs	Wang – EPS

Particle Chemical Characterization Measurements				
Size distribution (<0.05 – 15 μm) of inorganic species and mass	Impactor (MOUDI-static) IC and micro-balance	12-hrs	2/day	Brook/Li – MSC
Size distribution (<0.05 – 15 μm) EC/OC	Impactor (MOUDI-rotate) TOT	12-hrs	2/day	Brook – MSC
Size distribution (<0.05 – 15 μm)	Impactor (MOUDI) Foils	To be decided	To be decided	Pryor – Indiana U.
Black carbon	Optical absorption	1-hr	Continuous	Sharma – MSC
Black carbon	FP - Raman spectroscopy	1-2 hrs	4/day	Sloan – U. Waterloo
Black carbon	LIPM	2 per day	2/day	Nejedly – U. Guelph
Mass (<2.5 μm)	TEOM	1-min	Continuous	Brook – MSC
Mass (<2.5 μm)	FP - microbalance	24-hrs	One/day	Brook - MSC
Water soluble inorganic and organic species (<2.5 μm)	FP – IC	4 hrs day, 8 hrs night	5/day	Brook/Li – MSC
OC/EC (<2.5 μm)	FP - TOT	4 hrs day, 8 hrs night	5/day	Brook – MSC
Detailed Organic Speciation				
Size distributed speciation	Aerodyne Aerosol Mass Spectrometer	1-min	Continuous	Worsnop – Aerodyne
Carbon isotope (<2.5 μm and 2.5-15 μm)	Hivol FP – TOT-IRMS, GC-IRMS	12-hrs	2/day	Brook/Huang/Li – MSC
Trace organics species – non-polar (<2.5 μm)	Hivol FP – solvent extraction – GCMS	12-hrs	2/day	Brook/Li/Blanchard /Cheng – MSC
Trace organics species – polar (<2.5 μm)	Hivol FP – solvent extraction – GCMS/GC FID	12-hrs	2/day	Brook/Li/Blanchard /Cheng – MSC
Trace organics species – polar (<2.5 μm)	Hivol FP – solvent extraction – derivatization -GCMS/GC FID	12-hrs	2/day	McLaren – York U. McCarry – McMaster
Trace organics	Hivol FP	12-hrs	2/day	Rudolph – York U.
S-isotope	Hivol FP - MS	24-hrs	1/day	Norman – U. Calgary
C-isotope	Hivol FP – TOT-IRMS, GC-IRMS	Cumulative weekly	1/week	Whiticar – U. Vic
Air toxics	Hivol – solvent extraction – GC/MS	24-hrs	1/day	Harner – MSC
Gas-particle partitioning of semivolatile organics	IOGAP sampling – solvent extraction – GC/MS, Alkanes, PAH	24-hrs	1/day	Mihele/Lane – MSC

Gas-particle partitioning of semivolatile organics	HiCap sampling – solvent extraction – GC/MS, Alkanes, PAH	24-hrs	1/day	Mihele/Lane – MSC
Gas-particle partitioning of total semivolatile organics	IOGAP, TOT	12-hrs	2/day	Fan/Mabury – U. Toronto Brook – MSC
Polar OC	Chemvol-impactor	TBD	TBD	Fan/Mabury – U. Toronto Brook – MSC
Particle Physical Characterization Measurements				
Ultrafine particle number size distribution (6 – 300 nm)	DMA	10-min	Continuous	Brook – MSC
Fine particle number size distribution (0.12 – 3 μm)	Optical scattering (PCASP)	1-min	Continuous	Brook – MSC
CN	Optical counter	1-min	Continuous	Leaitch – MSC
Meteorological Measurements and Vertical Profiling				
T, P, RH WS, WD at surface	Typical met package	1-min	Continuous	Brook – MSC
Tethersonde T, P, RH, WS, WD	Typical met package	1-hr	Continuous	Brook/Arnold – MSC
Tethersonde O_3	UV-photometry	1-hr	Continuous	Brook/Arnold – MSC

5.3. Measurements at the Langley Ecole Lochiel site

Measurements at the Langley Ecole Lochiel site are similarly intended to address all issues, with an emphasis on the transition from the urban mix to a suburban/rural setting, particularly the impact of agricultural sources on the particulate matter formation and evolution. Similar to the instrumentation package at Slocan Park site, the instrumentation package includes measurements in all five categories. Table 3 lists the measurements to be carried out at this site, the time resolution, and the expected principal investigators.

Table 3. Planned measurements at the Langley Lochiel Ecole site during the Pacific 2001 field study. Time resolutions of the measurements are also listed.

Species	***Technique***	***Time Resolution***	***Frequency***	***PI***
Gas Phase Measurements				
O_3	UV-photometry	1-min	Continuous	Anlauf – MSC
NO, NO_2	Chemiluminescence	1-min	Continuous	Hayden – MSC
NO_y	Chemiluminescence	1-min	Continuous	Anlauf – MSC
PAN/PPN	GC	5-min	Continuous	Bottenheim – MSC

H_2O_2	Optical absorption (TDL)	5-min	Continuous	Harris – York U.
HNO_3	Annular denuder	4-hour	5/day	Anlauf – MSC
HNO_2	Optical absorption (TDL, preferred)	5-min	Continuous	Harris – York U.
HNO_2	Annular denuder	4-hr	5/day	Anlauf – MSC
HNO_2	HPLC	5-min	Continuous	Anlauf – MSC Zhou – SUNY Albany
HNO_3	HPLC	5-min	Continuous	Anlauf – MSC Zhou – SUNY Albany
Speciated NMHC	Canister-capillary GC	Integrated 5-30 min	Every 3 hrs Every hour intensive	Bottenheim – MSC Wang – EPS
Non-particle forming biogenic VOC (isoprene, OVOCs)	On-site GC/MS/FID	2-hr	Continuous	Bottenheim – MSC
Particle-forming biogenic VOCs (mono-terpenes)	On-site GC/MS/FID	2-hr	Continuous	Bottenheim – MSC
NH_3	Optical absorption – TDL	1-min	Continuous	Harris – York U.
NH_3	coil-fluorescence	5-min	Continuous	Pryor – U. Indiana
SO_2	Pulse fluorescence	1-min	Continuous	Anlauf – MSC
CO	IR-absorption – gas correlation	1-min	Continuous	Anlauf – MSC
HCHO	Coil-Hantz reaction-fluorescence	1-min	Continuous	Macdonald – MSC
CH_3CHO	DNPH cartridge	4-hr	6/day	Wang – EPS
Solar radiation	Eppley	1-min	Continuous	Anlauf – MSC
HO_2/RO_2	Radical amplifier	1-5 min	Continuous	Mihele – MSC
Particle Chemical Characterization Measurements				
Size distribution (<0.05 – 15 µm) of inorganic species and mass	MOUDI Impactor – IC and micro-balance	10 hour	2/day	Anlauf/Li/Brook – MSC
Size distribution (<0.05 – 15 µm) of organic species and EC/OC	MOUDI Impactor – IC, GC/MS, TOT	10 hour	2/day	Brook/Li/Anlauf /Blanchard – MSC
Size distributed Mass	MOUDI Impactor – weighing	24-hour	1/day	Pryor – U. Indiana
Size distributed speciation	Aerodyne Aerosol Mass Spectrometer	1-min	Continuous	Worsnop – Aerodyne
Black carbon	Optical absorption	1-hr	Continuous	Sharma – MSC
Black carbon	FP - Raman spectroscopy	1-2 hrs	4/day	Sloan – U. Waterloo
Mass (<2.5 µm)	TEOM	1-min	Continuous	Anlauf – MSC
Mass (<2.5 µm)	Regular FP - microbalance	4-hrs	5/day	Brook – MSC
Carbon isotope	Hivol FP – IRMS	10-hour	2/day	Anlauf/Huang/Li – MSC

(<2.5 µm)				
Carbon isotope (<2.5 µm)	Hivol FP – IRMS	10-hour	2/day	Anlauf/Huang/Li – MSC
Carbon isotope (<2.5 µm)	Hivol FP - IRMS	Cumulative weekly	One/week	Whiticar – U. Victoria
Sulfur isotope (<2.5 µm)	Hivol FP - MS	24-hrs	One/day	Norman – U. Calgary
Bulk aerosol inorganic species (<2.5 µm)	Denuder FP – IC	4-hrs	5/day	Anlauf – MSC
Trace organics species – non-polar (<2.5 µm)	Hivol FP – solvent extraction – GCMS/FID	10-hrs	2/day	Li/Brook /Blanchard – MSC
Trace organics species – polar (<2.5 µm)	Hivol FP – solvent extraction – GCMS/FID	10-hrs	2/day	Li/Brook /Blanchard – MSC
Trace organics species – polar (<2.5 µm)	Hivol FP – solvent extraction – derivatization - GCMS/GC FID	10-hrs	2/day	McLaren – York U.
S-PAH, N-PAH (<2.5 µm)	Hivol FP – solvent extraction – GC/MS	10-hrs	2/day	McCarry – McMaster U.
Air toxics	Hivol – solvent extraction – GC/MS	24-hrs	1/day	Harner – MSC
Gas-particle partitioning of semivolatile organics	IOGAP sampling – solvent extraction – GC/MS	24-hrs	1/day	Mihele/Lane – MSC Gundel – LLNL
Particle Physical Characterization Measurements				
Ultrafine particle number size distribution (6 – 300 nm)	DMA	10-min	Continuous	Leaitch – MSC
Fine particle number size distribution (0.12 – 3 µm)	Optical scattering (PCASP)	1-min	Continuous	Leaitch – MSC
Coarse particle number size distribution (>10 µm)	Optical scattering (FSSP300)	1-min	Continuous	Leaitch – MSC
CN	Optical	1-min	Continuous	Leaitch – MSC
CCN			Continuous	Leaitch – MSC
H_2O, Hygroscopicity	Thermal method	10-min	Continuous	Leaitch – MSC
Backscattering	Optical	1-min	Continuous	Leaitch – MSC
Meteorological Measurements and Vertical Profiling				
Vertical profile and spatial distribution	Scanning lidar	10-min	Continuous	Strawbridge – MSC

of aerosol scattering				
T, P, RH WS, WD at surface	Typical met package	1-min	Continuous	Anlauf – MSC
Met Sonding	Typical met package	To be relocated to Langley Poppy High School	4/days	Froude – MSC
Tethersonde T, P, RH, WS, WD	Typical met package	To be relocated to Langley Poppy High School	4/days	Steyn/McKendry – UBC
Tethersonde O_3, CO	UV-photometry IR absorption	To be relocated to Langley Poppy High School	4/days	Steyn/McKendry – UBC
Tethersonde particle number size distribution (0.3-10 μm)	Optical scattering	To be relocated to Langley Poppy High School	4/days	Steyn/McKendry – UBC
Column abundance of O_3, NO_2, SO_2, J-Value	Spectrograph	5-min	Continuous	Evans – Trent U.
Column solar absorption due to O_3, CO, and aerosols	High resolution FTS	5-min	Continuous	Evans – Trent U.
CO, O_3, CH_4, N_2O, CO_2 profile	Long path IR absorption	5-min	Continuous	Evans – Trent U.

5.4. Measurements at the Golden Ears Provincial Park

Different from the other sites, the Golden Ears Provincial Park site is dedicated to the question of secondary biogenic particles production from forestry precursors. Emissions inventory for the Lower Fraser Valley indicates strong sources of precursor monoterpenes from the north shore mountains in the Lower Fraser Valley, for example, in the mountains north of North Vancouver and north of Maple Ridge, as well as south of the US-Canada border. The monoterpenes are converted into particles in the gas phase with high yields. While there is a strong reason to believe that the mountains, covered with coniferous forest, can be a significant source of biogenic precursors to PM, it is not clear whether the strong contrast at the border is real. Based on the current emissions inventories, studies using the ISOPART model (a lagrangian model) indicate significant contribution to the PM level in the valley from the biogenic sources. To probe the best possible locations for this type of study, there is a preliminary study this summer at a few locations in the valley, including a site just on the northern edge of North Vancouver, in the UBC Research Forest north of Maple Ridge, and a site near the US-Canada border. The results from this preliminary study will help decide the site location most suitable for this purpose for Pacific 2001.

Table 4. The measurement activities at the Golden Ears provincial park site.

MEASUREMENT	INSTRUMENT	TIME RESOLUTION	FREQUENCY	PI
Particle Conc. and Size				
Total number >10 nm	3022	5-min	Continuous	Leaitch – MSC
Ultrafine	UF DMA (3025)	5-min	Continuous	Leaitch – MSC (Leaitch/Graham)
3 nm to 200 nm	DMA (3025)	5-min	Continuous	Leaitch – MSC
0.12 μm to 3μm	PCASP	5-min	Continuous	Leaitch – MSC
0.05 μm to 10 μm	ELPI	5-min	Continuous	Leaitch – MSC (Leaitch/Graham)
Physical Characterization of Particles				
Hygroscopicity and volatility	TDMA (7610 and 3010)	5-min	Continuous	Mozurkewich – York U.
CCN	Wyoming	5-min	Continuous	Leaitch – MSC
Trace Gases				
VOCs	On-site GC/MS/FID	2-hr	Continuous	Brickell – MSC
O3	TECO 49	1-min	Continuous	GVRD
SO2	TECO 43S	1-min	Continuous	Leaitch – MSC
ROOH, H2O2	Coil-enzyme-fluorescence	5-min	Continuous	Anlauf – MSC
Chemical Characterization of Particles				
Inorganic ions	Lowvol Teflon filters	4-hrs	5/day	Leaitch – MSC
TOC, BC, WSI/OC	Lowvol Quartz filters	4-hrs	5/day	Leaitch – MSC
Ketones, oxi-products	Hivol FP – solvent extraction – GCMS/FID	10-hrs	2/day	Li – MSC
Carbon isotopes (>2.5 um)	Hivol FP - IRMS	12-hrs	2/day	Huang – MSC
Carbon isotopes (<2.5 um)	Hivol FP - IRMS	12-hrs	2/day	Huang – MSC
Met Measurements				
Met	Std met package	1-min	Continuous	
Winds, T	Std met package	1-min	Continuous	Leaitch – MSC

5.5. Measurements at the Eagle Ridge site on Sumas Mountain

The Eagle Ridge site at the Sumas Mountain is chosen for characterization of aerosols for optical, chemical and physical properties as well as impacts from biogenic sources. The main objectives are (1) to attempt to obtain mass and optical closure in order to better attribute aerosol types and sources to the issues of PM and visibility, (2) to determine the contribution of non-volatile organic compounds (HMW alkanes, carbonyls and acids), biogenic VOCs, and NH3 to particle mass. The site is located at an elevation of 300 meters and is within the mixed boundary layer most of the time and hence is ideal for monitoring changes from light to dark hours. It is on top of a hill, surrounded by trees but not far from the secondary urban center of Abbotsford. Hence local pollution impact is also expected. Because of the elevation, fetch in all direction is good. To the south of the site in the valley, NH_3 emissions are strong, and their impact of aerosol particle formation and hence the visibility reduction is expected to be significant. Studies are also designed to measure the NH_3 impacts on the particle formation at this location.

Table 5. Planned measurements at the Eagle Ridge site on Sumas Mountain during the Pacific 2001 field study. Time resolutions of the measurements are also listed.

MEASUREMENT	INSTRUMENT	TIME RESOLUTION	FREQUENCY	PI
Physical Size Distribution				
Total number >15 nm	7610	5-min	Continuous	Mozurkewich - York
Ultrafine	UF DMA (3025)	5-min	Continuous	Leaitch - MSC (Leaitch/Graham)
3 nm to 200 nm	DMA (3025)	5-min	Continuous	Mozurkewich - York
0.12 μm to 3μm	PCASP	5-min	Continuous	Leaitch – MSC
0.05 μm to 10 μm	ELPI	5-min	Continuous	Leaitch - MSC (Leaitch/Graham)
Physical characterization				
Hygroscopicity and volatility	TDMA (7610 and 3010)	5-min	Continuous	Mozurkewich – York
Chemistry and physics of volatilized particles	Furnace, denuders, PCASP and DMA (3022)	5-min	Continuous	Wiebe – MSC
Total mass - dry	TEOM – 2.5 μm	5-min	Continuous	GVRD
Total mass - dry	Filters - Gravimetric	4-hours	5/day	Brook – MSC
CCN	Wyoming	5-min	Continuous	Leaitch – MSC
Optical Measurements				
Light scattering, wet and dry	Nephelometer	1-min	Continuous	Leaitch – MSC
Light absorption and BC	PSAP	30-min	Continuous	Sharma – MSC
Optical depth	Sun photometer	1-min	Continuous	Campanelli – IFA
Trace Gases				
VOCs	Canisters	integrated	To be decided	Rudolph – York
VOCs	GC-MS	1-hour	Continuous	McLaren – York
NO, NO2, CO	Eco Physics	5-min	Continuous	Anlauf – MSC
O3	TECO 49	5-min	Continuous	GVRD
SO2	TECO 43S	5-min	Continuous	Leaitch – MSC
ROOH, H2O2	Coil-enzyme-fluorescence	5-min	Continuous	Anlauf – MSC
HCHO	Coil-HR-fluorescence	5-min	Continuous	Macdonald – MSC

HNO3	Coil-fluorescence	5-min	Continuous	Pryor - U. Indiana
NH3	Coil-fluorescence	5-min	Continuous	Pryor - U. Indiana
HCHO, GA …	Automated HPLC	15-min	Continuous	McLaren – York
Chemical Characterization of Particles				
Inorganic ions, HNO2, HNO3, NH3, SO2	Teflon filters downstream of NaCl, NaCO3 and CA denuders	4-hour	5/day d	Wiebe – MSC
TOC, BC, WSI/OC	Quartz filters	4-hour	5/day	Leaitch/Li – MSC
Size-segregated EC/OC	MOUDI - Quartz	10 hour	2/day	Brook – MSC
Size-segregated Inorganic Composition	MOUDI - Teflon	10 hour	2/day	Leaitch/Li – MSC
Carbonyls, diacids (C2-C9)	Hi-vol – GC-MS/FID	8-hour	2/day	McLaren – York
Aromatics, PAHs	Hivol FP – solvent extraction – GCMS/FID	8-hour	2/day	Rudolph – York
Alkanes, biomarkers, acids, diacids	Hivol FP – solvent extraction – GCMS/FID	8-hour	2/day	Blanchard – MSC
Ketones, oxi products	Hivol FP – solvent extraction – GCMS/FID	8-hour	2/day	Li – MSC
Carbon isotopes (>2.5 um)	Hivol FP – IRMS	12-hour	2/day	Huang – MSC
Carbon isotopes (<2.5 um)	Hivol FP – IRMS	12-hour	2/day	Huang – MSC
Carbon isotopes - weekly	Hivol FP – IRMS	Integrated	1/week	Whiticar - U. Victoria
PAHs, acids, oxi products	Hivol FP – solvent extraction – GCMS/FID	24-hour	1/day	McCarry – McMaster
Met Measurements				
Winds, T, Td, Pressure	Std met package	1-min	Continuous	GVRD
Winds, T	Std met package	1-min	Continuous	Leaitch – MSC

5.6. Measurements at other sites

Other activities are considered for the purpose of providing boundary conditions. At the Reiffel Island site, an O_3 monitor will run continuously at a 1-min resolution. At the current TSRI site at Burnaby South High School, measurements on particle mass and chemical composition continue along with the GVRD regular monitoring activities. Four mini-vol samplers are to be setup at locations in the vicinity of the Slocan Park site or the Burnaby

South High School site. These samplers will be used to collect filter samples for organic carbon/elemental carbon analysis.

In addition, measurements at the GVRD monitoring network continue. At all sites, meteorological measurements will be carried out at a 5-min time resolution. At a few specially equipped sites, measurements of particle mass $PM_{2.5}$ and PM_{10} using TEOMs will be operational during the Pacific 2001 study period. Measurements for particle organic carbon and elemental carbon will also be carried out at selected GVRD sites using the RP5400 monitors on an experimental basis. This complements the limited spatial coverage of the four special study sites. Together, they form a spatial distribution of the gas phase pollutants.

5.7. Airborne measurement components

The airborne measurement component consists of remote sensing of aerosol backscattering, as well as in-situ measurements of particle number size distribution, O_3, CO concentrations, and meteorological parameters. Model domain boundary conditions will be carried out using the airborne platform to provide input to initiate model runs that are to be evaluated against the field measurements.

Two aircraft will take part in the measurement program, the NRC IAR Convair 580 and the CFS Cessna 188. The measurement tasks for both aircraft are listed in Table 5 and Table 6, respectively. The detailed flight plans for both aircraft are prepared and available separately [Strapp and Chevrier, 2001]. In addition to the two Canadian aircraft, the Pacific Northwest National Laboratory (PNNL) of the US Department of Energy will conduct an aircraft campaign, the Pacific Northwest 2001 (PNW 2001), at the same time in the Strait of Georgia and the Puget Sound to look at air quality issues, in particular, the drainage flows from the Vancouver urban airshed into the Strait of Georgia and further transport into the Puget Sound. Dr. Len Barrie of the PNNL is leading this aircraft measurement program.

5.7.1. The Convair 580

The main mission for the Convair 580 is to carry out mapping of PM distribution in the valley through remote sensing using lidar, and to provide critical meteorological data, such as boundary met conditions. The Convair 580 has an airborne time of approximately 4-5 hours per flight and can fly from about 1500 feet to 23 kft altitude. It has a large payload and can accommodate two lidars, upward and downward looking lidar. It also has many other capabilities including the range.

Briefly, the Convair flight plans [Strapp and Chevrier, 2001] calls for mostly meridional legs of lidar tracks over the Lower Fraser Valley, with the eastern boundary at 121°52'30"W and the western boundary at 123°50'13"W. A typical flight will cover the Lower Fraser Valley in 11 north-south legs, approximately equally spaced, with three of them directly over the ground sites. These tracks extend from 48°30'N to 49°30' N over the mountain tops. The boundaries correspond roughly to the model domain of Model 3/CMAQ application to the region. A second flight plan calls for east-west lidar tracks to probe the urban-suburban-rural gradient, with additional tracks over the north shore lakes to help understand the valley flow situation. The second plan also incorporate vertical profiling over the Strait of Georgia to the west and south of Vancouver at the western boundary and southern boundary of the domains to provide model domain boundary conditions for met, ozone, particle physics and number counts. The flight plans for the Convair 580 also calls for nighttime missions to understand the continued spatial evolution of PM from daytime and changes in the boundary layer structure in the valley. The nighttime mission may be limited due to logistical reasons. Table 6 lists the measurements that are planned for the Convair 580.

Table 6. Planned measurements from the Convair 580 during Pacific 2001 experiment.

Missions	***Technique***	***Flight Altitude***	***Frequency***	***PI***
Aerosol backscattering	Lidar	>14 kft	1-2 flights/day	Strawbridge – MSC
In situ meteorology (T, P, RH, WD, WS, radiation)	Typical met package		1-2 flights/day	Strapp – MSC
Particle Size Distribution	Optical probes	Varying altitude	1-2 flights/day	Strapp – MSC
CN	CNC counter	Varying altitude	1-2 flights/day	Strapp – MSC
Backscattering	Nephelometer	Varying altitude	1-2 flights/day	Strapp – MSC
Boundary met conditions (T, P, RH, WD, WS)	Typical met package – profiling	Varying altitude	1-2 flights/day	Strapp – MSC
Column abundance of O_3, CO, and aerosols below aircraft	High resolution FTS	No requirement	1-2 flights/day	Evans – Trent U.
Air toxics	Semi-hivol – solvent extraction – GC/MS	No requirement	To be decided	Harner/Li – MSC

5.7.2. The CFS Cessna 188

The CFS Cessna 188 is a single person small aircraft with a high degree of maneuverability. Its main attractions are three fold, the low cost, ability to flight low in the boundary layer, and flexibility in flight planning. The CFS Cessna had been instrumented before with a particle probe and an Hg monitor. It can be outfitted with a second particle probe and two monitors without the Hg monitor. The planned Pacific 2001 measurements are listed in Table 7.

Table 7. Planned measurements from the CFS Cessna during Pacific 2001 experiment.

Missions	***Technique***	***Flight Altitude***	***Frequency***	***PI-Affiliation***

Particle number size distribution (0.12 – 3 μm)	Optical scattering particle probe	100 – 10000 ft	Continuous during flight	Leaitch – MSC
Particle number size distribution (1– 20 μm)	Optical scattering particle probe	100 – 10000 ft	Continuous during flight	Leaitch – MSC
CN	CN counter	100 – 10000 ft	Continuous during flight	Leaitch – MSC
Aerosol chemical composition	FP – lab analysis	1000 ft	2/flight	Li – MSC
Aerosol elemental size distribution	Impactor-SEM-particle morphology	1000 ft	2/flight	Li – MSC
O_3	UV photometry	100 – 10000 ft	Continuous during flight	Anlauf – MSC
CO	IR absorption – gas correlation	100 – 10000 ft	Continuous during flight	Anlauf – MSC
VOC	Canisters	100 – 10000 ft	8/flight	Bottenheim – MSC
T, P, RH, WD, WS	Typical met package	100 – 10000 ft	Continuous during flight	Strapp – MSC

The planned CFS mission is one of supporting the ground-based measurements from mostly the Slocan Park site, the Langley Ecole Lochiel site, and the Eagle Ridge site on Sumas Mountain. Tight integration of the measurements from the Cessna with those on the ground level will provide a clearer picture of the vertical chemical and thermal structure of the lowest part of the boundary layer, as well as how the particle physical characteristics changes with altitude within the boundary layer.

The current flight plans call for three different flying patterns, 1) profiling; 2) spatial coverage, and 3) specialized flight patterns. Details can be found in the flight plans [Strapp and Chevrier, 2001]. The profiling will take place over the ground level sites as well as at the model boundaries. The profiling will provide vertical distributions of O_3, CO, particle number size distribution and total particle counts, and VOCs as well as meteorological parameters at the selected locations. The spatial mapping will take place at <1000 ft altitude, during which the aircraft will fly north-south tracks with a resolution of about 5 km. During these flight tracks, filters will be collected, with one filter covering mostly the urban areas and the other covering most of the suburban/rural areas, for analyses for inorganic and OC/EC components. Race-track flight patterns may be performed over the sites to collect specific filter samples for comparison with the ground based measurements.

6. Quality Assurance and Data Management

The Pacific 2001 Quality Assurance and Data Management Program is operated by the Meteorological Service of Canada, Air Quality Measurements and Analysis Division. This QA Program focuses on ensuring that PIs: (1) develop suitable Quality Assurance Project

Plans (QAPjPs), (2) pre-define Data Quality Objectives (DQOs), (3) incorporate QA procedures into their measurement systems, (4) carry out measurements in accordance with their QAPjPs, and (5) at the closure of the study, determine and report their final Data Quality Indicators (DQIs). Included in the QA Program will be a limited performance audit to be carried out during the field campaign. Given the complexity of most of the measurements, it will not be possible to audit all measurements used in the campaign. Hence, individual PIs will be responsible for designing and implementing their own methods for assuring the accuracy, precision, completeness, comparability, and representativeness of their measurements. Performance audits will be carried out only on ozone, flow measurements, and meteorological measurements. During the audits, on-site checks will be made to ensure that the QA/QC elements of the QAPjPs are carried out as planned. As a result of the QA Program, the Pacific 2001 Quality Assurance Plan has been developed based on the QAPjP and is available separately [Vet et al., 2001].

The Data Management Program will focus on ensuring that data are collected and archived properly and efficiently. The goal will be to produce both metadata and data archives for all surface measurement data (note that aircraft, lidar and balloon data will not be part of this activity). A workshop on Data Management will be held prior to the field campaign (April/May of 2001) to standardize the data handling and archiving methods for the study. A data management guide [Sukloff, 2001] has been distributed to the individual PIs to help manage the expected large data volume. Individual PIs will be responsible for submitting their final, quality-controlled data to the database within two years of the field study. To assist staff with data submission, computer templates will be created and staff will be trained on their use. Assistance and training will also be given to any staff wishing to use AQRB's RDMQ™ software to quality control and manage their data. Ultimately, the Pacific2001 Surface Database will become part of the NAtChem (National Atmospheric Chemistry) family of chemical databases and will be accessible through the World Wide Web.

The following key activities constitute the QA and Data Management Program (by year):

In 2000:

- Preparation of a formal QA Plan for the study
- Preparation of individual QA Project Plans by the principle investigators
- Design of databases for both the metadata and the surface measurement data
- Host a formal Pacific2001 Data Workshop for field study participants
- Design templates to assist campaign staff with data submission

In 2001

- Train staff on data submission templates and methods
- Assist staff in the adaptation of the RDMQ™ software system for quality controlling data
- Carry out performance audits during the field campaign
- Design a Web-based data access system for surface data.

In 2002

- Prepare a formal QA report for the field campaign
- Populate the metadata and data bases
- Quality assure the data submissions to the database
- Provide a Web-based data access system for the surface data.

The ultimate deliverable of the QA and DM activity will be an accessible database of surface measurement data accompanied by information on the quality of the data.

7. Persons in charge and participating scientists

The persons with responsibilities for the operation of the individual components of the programs are listed here.

Anlauf – Coordinator for the Langley Ecole Lochiel site
Belzer – Logistic Coordinator
Brook – Coordinator for the Slocan Park site
Harris – Coordinator for the CFCAS activities
Gallant – Safety Coordinator
Graham – Coordinator for tunnel study at the Cassier Tunnel
Leaitch – Coordinator for the Eagle Ridge and Golden Ears sites
Li – Project Leader, and also aircraft operation
McLaren – Coordinator for the Eagle Ridge site
Strapp – Coordinator for aircraft operation
Strawbridge – Responsible for Convair 580 lidar mapping and ground scanning lidar
Vet – Coordinator for Quality Assurance and Data Management Program

The management team consists of Bruce Thomson, Keith Puckett, and Maris Lusis.

In total, over 130 researchers from several branches of the Canadian federal government, 14 universities in Canada, US, and UK, private research institutes, provincial and local governments will participate in the program. The principal investigators, their interests, and contact information are listed in the following table.

Table 7. The participating scientists, their interest, and contact information.

Scientist	Interest	Email	Phone
Meteorological Service of Canada (MSC), Environment Canada			
Kurt Anlauf	O_3, NO, NO_2, NO_y, H_2O_2, CO, SO_2	Kurt.Anlauf@ec.gc.ca	416-739-4840
Jan Bottenheim	Biogenics, VOC's, PAN	Jan.Bottenheim@ec.gc.ca	416-739-4838
Pierrette Blanchard	Organic species in PM	Pierrette.Blanchard@ec.gc.ca	416-739-4268
Jeff Brook	Mass and chemistry of PM	Jeff.Brook@ec.gc.ca	416-739-4916
Frank Froude	Radio sonding	Frank.Froud@ec.gc.ca	705-458-3302
Tom Harner	Air Toxics	Tom.Harner@ec.gc.ca	416-739-4837
Lin Huang	PM carbon isotope	Lin.Huang@ec.gc.ca	416-739-5821
Doug Lane	Gas-particle partitioning of	Douglas.Lane@ec.gc.ca	416-739-4859

	organics		
Richard Leaitch	Physics of PM, H_2O content	Richard.Leaitch@ec.gc.ca	416-739-4616
Shao-Meng Li	Chemistry of PM	Shao-Meng.Li@ec.gc.ca	416-739-5731
Anne Marie Macdonald	HCHO	AnneMarie.Macdonald@ec.gc.ca	416-739-4465
Paul Makar	modeling to run on-site and predict VOC products and PM components	Paul.Makar@ec.gc.ca	416-739-4692
Cris Mihele	Gas-particle partitioning	Cristian.Mihele@ec.gc.ca	416-739-5921
Sangeeta Sharma	Black carbon	Sangeeta.Sharma@ec.gc.ca	416-739-5820
Walter Strapp	Aircraft operation	Walter.Strapp@ec.gc.ca	416-739-4617
Kevin Strawbridge	Lidar	Kevin.Strawbridge@ec.gc.ca	705-458-3314
Bill Sukloff	Data center operation	Bill.Sukloff@ec.gc.ca	416-739-5722
Al Wiebe	O_3, NO, NO_2, NO_y, H_2O_2, CO, SO_2, NH_3	Allan.Wiebe@ec.gc.ca	416-739-5823
Bob Vet	Data QA/QC	Bob.Vet@ec.gc.ca	416-739-4454
Pacific and Yukon Region, Environment Canada			
Wayne Belzer	Project support	Wayne.Belzer@ec.gc.ca	604-664-9125
Bruce Thomson	Project management support	Bruce.Thomson@ec.gc.ca	604-664-9122
Environmental Protection Service (EPS), Environment Canada			
Tom Dann	Enhanced NAPS surveillance, HC	Dann.Tom@etc.ec.gc.ca	613-991-9459
List Graham	Tunnel study	Graham.lisa@etc.ec.gc.ca	613-990-1270
Danny Wang	NMHC, biogenic HC	Wang.Daniel@etc.ec.gc.ca	
National Research Council			
Don Singleton	Model 3/CMAQ	Don.Singleton@nrc.ca	613-993-2500
Weimin Jiang	Model 3/CMAQ	Weimin.Jiang@nrc.ca	613-998-3992
Dave Marcotte	Convair 580 operation	Dave.Marcotte@nrc.ca	613-998-3071
Canadian Forestry Service			
Art Robinson	Cessna 188 operation		
Dave Roden	Research scientist/CFS		
University of British Columbia			
Roland Stull	MC2 modeling	rstull@geog.ubc.ca	604-822-5901
Josh Hacker	MC2 modeling	jhack@geog.ubc.ca	604-822-6620
Douw Steyn	Boundarly layer meteorology, O_3, PM	douw@geog.ubc.ca	604-822-8995
Ian McKendry	Boundary layer meteorology, O_3, PM	ian@geog.ubc.ca	604-822-4929
Michael Brower	Health Impact of PM		
University of Calgary			
Ann Lise Norman	Sulfur isotope in PM	annlisen@phas.ucalgary.ca	403-220-5405
University of Guelph			
Zdenek Nejedly	Black carbon using LIPM	nejedly@physics.uoguelph.ca	519-824-4120 x3009; x8397
University of Shebrooke			
Norm O'Neill	Optical properties		
Raman Thulasiraman	Optical properties		
University of Toronto			
Scott Mabury	Organic compounds in PM, metals in PM	smabury@alchemy.chem.utoronto.ca	
University of Waterloo			
Jim Sloan	Black carbon in PM	sloanj@UWaterloo.ca	519-888-4401

University of Victoria			
Mike Whiticar	Carbon isotope in PM	whiticar@uvic.ca	
MacMaster University			
Brian McCarry	Organic carbon speciation		
Trent University			
Wayne Evans	Remote sensing of column abundance of O_3, CO, CO_2, CH_4, and aerosol absorption	wevans@trentu.ca	
York University			
Geoff Harris	HCHO, HNO_2, HNO_3, NH_3, OH	gharris@yorku.ca	416-736 5992
Don Hastie	Data management	hastie@yorku.ca	416-736 5388
Rob MacLaren	Organic aerosols	rmclaren@turing.sci.yorku.ca	416-736-2100 ext. 30675
Mike Mozurkewich	Aerosol physics	mozurkew@yorku.ca	
Jochen Rudolph	Biogenic hydrocarbons, VOCs	rudolphj@yorku.ca	
Colorado State University			
Toni Prenni	Ultrafine particle evolution		
University of Indiana			
Sara Pryor	NH_3	spryor@indiana.edu	812-855-5155
Aerodyne Research Incorporated			
Doug Worsnop	Aerosol mass spectrometry	worsnop@aerodyne.com	
Manjula Canagaranta	Aerosol mass spectrometry	mrcana@aeroodyne.com	
Hacene Boudrie	Aerosol mass spectrometry		
State University of New York – Albany			
Xianliang Zhou	Gas phase HONO measurements	zhoux@wadsworth.org	
Pacific Northwest National Laboratory			
Len Barrie	Aircraft mission in LFV	Leonard.Barrie@pnl.gov	509-375-3998
Istituto de Fisica dell'Atmosfera			
Monica Campanelli	Sun photometer		
University of Manchester Institute of Science and Technology (UMIST)			
Hugh Coe	Aerosol mass spectrometry	hugh.coe@umist.ac.uk	44-161-200-3935
Keith Brower	Aerosol mass spectrometry	K.Bower@umist.ac.uk	

8. Major events

- Project plan documents: Project Plan, Flight Plan, and Quality Assurance Plan
  July 2001
- Field Study, 2001
  - For Slocan Park, Langley, and Eagle Ridge sites: August 13 – September 1
  - For lidar: July 20 – September 1
  - For Tunnel study and Golden Ears: August 3 – August 10
- Initial Field Study Meta Data Report
  October 2001
- First data submission to Data Center
  December 2001
- Second data submission to Data Center
  March 2002
- Workshop in Vancouver

April 2002, Report on workshop

- Final data submission to Data Center
  December 2002
- Special session at the AGU (or the CMOS)
  December 2002 (or May 2003)
- Special issue in Atmospheric Environment
  June 2003

9. References

Biesenthal, T.A., et al., A study of relationships between isoprene, its oxidation products, and ozone, in the Lower Fraser Valley, B.C., Atmospheric Environment, 31, 2049-2058, 1997.

Hoff R.M., et al., Use of airborne lidar to determine aerosol sources and movement in the Lower Fraser Valley (LFV), BC, Atmospheric Environment, 31, 2123-2134, 1997.

Gertler, A.W., et al., Characterization of vehicle emissions in Vancouver BC during the 1993 Lower Fraser Valley oxidant study, Atmospheric Environment, 31, 2107-2112, 1997.

Mckendry, I.G., et al., Elevated ozone layers and vertical down-mixing over the Lower Fraser Valley, BC, Atmospheric Environment, 31, 2135-2146, 1997.

Pisano, J.T., et al., Vertical nitrogen dioxide and ozone concentrations measured from a tethered balloon in the Lower Fraser Valley, Atmospheric Environment, 31, 2071-2078, 1997.

Pryor S.C. and Barthelmie R.J. (1996): REVEAL II: Characterizing fine aerosols in the Lower Fraser Valley. Final report of Part 1 analysis and database. Submitted to Fraser Cheam Regional District, Chilliwack.

Pryor S.C. and Barthelmie R.J. (1999): REVEAL II: Characterizing fine aerosols in the Lower Fraser Valley. Final report of data analysis and database construction. Submitted to Fraser Cheam Regional District, Chilliwack.

Rogak, S.N. Green S.I., and Pott, U., Use of tracer gas for direct calibration of emission-factor measurements in a traffic tunnel, J. Air Waste Management Assoc., 48, 545-552, 1998a.

Rogak, S.N., Pott, U, Dann T., Wang D., Gaseous emissions from vehicles in a traffic tunnel in Vancouver, British Columbia, J. Air Waste Management Assoc., 48, 604-615, 1998b.

Strapp, J., and W.T. Chevrier, Pacific 2001 flight plan report, 26p, June 2001.

Sukloff, B., Pacific 2001 Data Management Guide, 15p, June 2001

Vet, R., B. Sukloff, and S.-M. Li, The Pacific 2001 Quality Assurance Plan, 400p, July 2001.